Uniform Distribution

Commonly used to model variables that have constant probability between values a and b.

$$X \sim Unif(a, b)$$

- Probability Mass Function (PMF)

$$f(x) = \frac{1}{b-a} \quad \text{for } a < x < b$$

- Cumulative Distribution Function (CDF)

$$F_X(t) = P(X \le t) = \begin{cases} 0 & \text{for } t \le a \\ \frac{t-a}{b-a} & \text{for } a < t < b \\ 1 & \text{for } t \ge b \end{cases}$$

- Expected Value: $E(X) = \frac{a+b}{2}$
- Variance: $Var(X) = \frac{(b-a)^2}{12}$

Exponential Distribution

Commonly used to model waiting times between single occurrences.

$$X \sim Exp(\lambda)$$

- Probability Mass Function (PMF)

$$f(x) = \lambda e^{-\lambda x} \quad \text{for } x > 0$$

- Cumulative Distribution Function (CDF)

$$F_X(t) = P(X \le t) = \begin{cases} 0 & \text{for } t \le 0 \\ 1 - e^{-\lambda t} & \text{for } t > 0 \end{cases}$$

- Expected Value: $E(X) = \frac{1}{\lambda}$
- Variance: $Var(X) = \frac{1}{\lambda^2}$

Gamma Distribution

Commonly used to model total time for a procedure composed of α independent occurrences, where the time between each occurrence follows $Exp(\lambda)$ distribution.

$$T \sim Gamma(\alpha, \lambda)$$

- Obtain relevant probabilities using Gamma-Poisson Formula
  For $T \sim \text{Gamma}(\alpha, \lambda)$ and $X \sim \text{Pois}(\lambda t)$,

$$P(T > t) = P(X < \alpha)$$

and

$$P(T \le t) = P(X \ge \alpha)$$

- Expected Value: $E(T) = \frac{\alpha}{\lambda}$
- Variance: $Var(T) = \frac{\alpha}{\lambda^2}$

Normal Distribution

Commonly used to model a wide variety of variables that have a *"bell-shaped"* and *symmetric* shape.

$$X \sim N(\mu, \sigma^2)$$

- Obtain relevant probabilities using $z - table$
  - Standardize X to obtain Z, where $Z \sim N(0, 1)$
  - Standardization Formula: $Z = \frac{X-\mu}{\sigma}$
  - $\Phi(z) = P(Z \le z)$ found using $z - table$
- Expected Value: $E(X) = \mu$
- Variance: $Var(X) = \sigma^2$